Using the *Counting On* Mathematics Strategies: an action research case study

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describe an action research project designed to improve the place value, multiplication, and division skills of a group of students.

Katie[1], was required to engage in an action research (AR) project as part of a 10 week internship in the eighth semester of her BEd(Primary) course. Action research is defined by Macintyre (2000, p. 1) to be: 'an investigation, where, as a result of rigorous self-appraisal of current practice, the researcher focuses on a 'problem' (or a topic or an issue which needs to be explained), and on the basis of information ... plans, implements, then evaluates an action then draws conclusions on the basis of the findings'. AR is a "form of practical action which teachers undertake as part of, not separate from, their professional work" (Grundy, 1995, p. 7). The following is an account of an AR project which demonstrates how AR research can be undertaken as part of everyday teaching practice.

Identifying the question

Also known as the "reconnaissance phase", this is the first step is identifying the AR question. Katie undertook a reconnaissance to "ground" her AR in the realities of her workplace, to reflect on her professional practice in context, and to consider the

1 Katie was a final year BEd(Primary) student and Tom was her university supervisor.

benefits of professional opinion and relevant literature.

Nine of Katie's students were below the NSW average in mathematics. As she began taking on the teaching load for the mathematics key learning area, she began to notice these nine students had significant difficulties compared to the other students when completing mathematical calculations mentally. This was a concern because these skills are fundamental to being able to develop a deeper understanding of mathematical concepts and perform more complex calculations (NSW Department of Education & Training, 2004, pp. 5–6). The two areas with which the students had difficulty were multiplication and division, including the use of mental strategies. Testing revealed that the nine students had little concept of place value and used inefficient mathematical methods, such as counting by ones, to group numbers. These nine students became target students for Katie's AR project.

Katie knew that she would need to engage these students in activities which they believed they were capable of completing and that they found interesting. Following discussion with colleagues, she decided that the *Counting On* (NSW DET, 2004) mathematical games could achieve both of these objectives because they are designed to be accessible and entertaining. However, Katie had never been involved in actively implementing *Counting On* and realised that she would need to develop a deep knowledge about the games if she was going to base her lessons and research around its strategies. Her supervising teacher assisted by providing the DVDs and texts that comprised the *Counting On* teaching and learning package.

The *Counting On* program introduces a learning framework with five interrelated steps which are intended to move students from "naive strategies, to increasingly sophisticated strategies in order to solve number problems" (NSW DET, 2008. p. 5). This is illustrated in Figure 1. The aim is to assist students to progress from the lower steps, through to the highest step on the scale. At the upper point the student will have successfully acquired the skills to complete complex number problems.

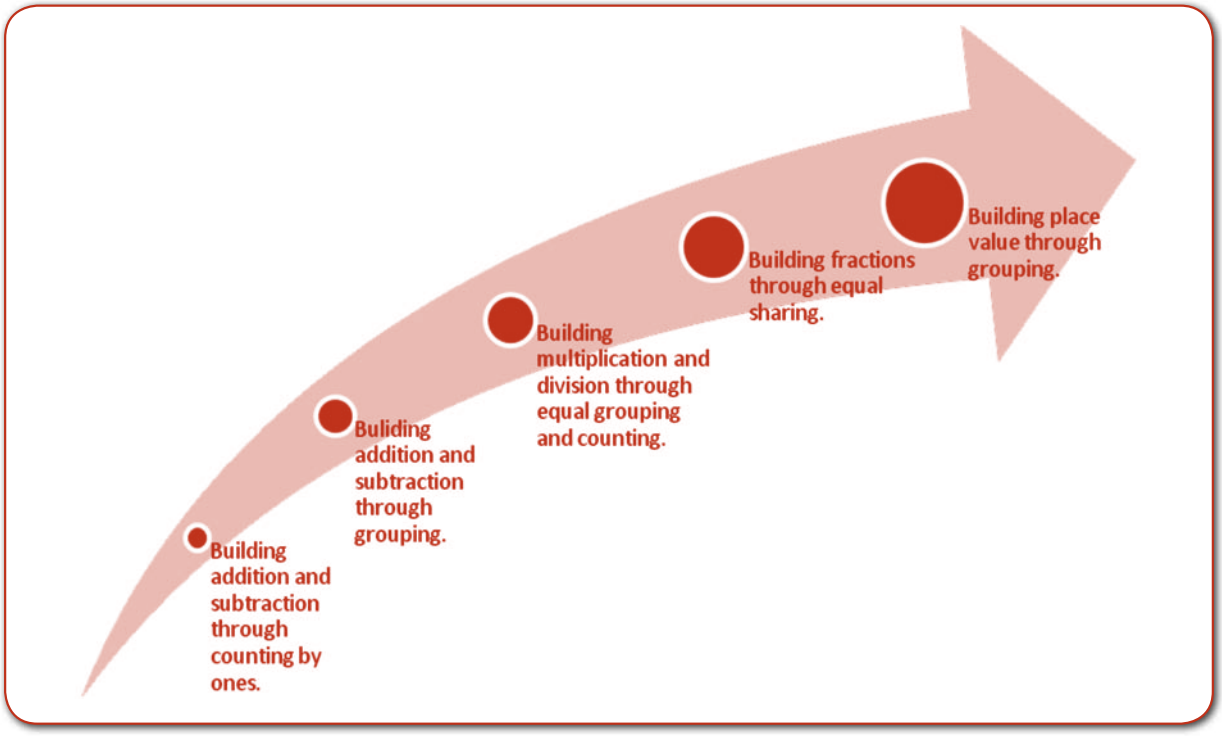

Figure 1. Counting On Learning Framework: Number (NSW DET, 2008, p. 5).

Further evidence of the likely effectiveness of the *Counting On* activities was provided by a report of an intervention using similar strategies that was conducted in Illinois (Fatta, Garcia & Gorman, 2009). Other research showed that establishing goal-setting and implementing a mentoring program to "reinforce mathematical concepts and skills", improved student motivation and achievement (Adami-Bunyard, Gummow, Milazzo-Licklider, 1998, p. 4). Katie took into account the strategies Adami-Bunyard et al. used for goal setting, by giving students individual goals for the project, as well as the group goal that "every student will improve their skills in place value and multiplication and division this term".

In addition to consulting the literature, Katie acted upon the advice of her supervising teacher, using two *Counting On* games per week and starting from the third step in the *Counting On* Learning Framework, as this is the level at which the majority of students were working (NSW DET, 2008, p. 6). Following this intensive work Katie was able to identify her AR question as follows:

> Can the third step in the *Counting On* mathematics program, "Building multiplication and division through equal grouping and counting", improve a group of targeted ... students' abilities to use more sophisticated numeracy strategies for multiplication and division, and allow them to progress from poor mathematical strategies to sophisticated strategies?

Action research cycle

The AR question prompted entry into the AR cycle (Kemmis & McTaggart, 1988). The cycle served as the analytical framework although, in reality, the four parts—plan, act, observe and reflect—were not as discrete as presented here.

Plan

After the reconnaissance phase and the development of the AR question, two plans were developed: for "action" and for "observation", that is, data gathering. During the remaining 8 weeks of the internship was as follows; the nine target students spent 15 minutes per day, separate from the rest of the class, engaging in mathematical activities based around place value, multiplication and division from the *Counting On* program. Two activities were completed each week, with the first activity being modelled and attempted on Monday, and repeated again on Tuesday. The second activity was modelled and attempted on Wednesday and repeated again on Thursday. On Friday each student was given the opportunity to choose an activity to participate in from any of the activities learned that week.

There were four data gathering strategies. Firstly, a student survey was conducted in Weeks 3, 6 and 10. This survey required the students to assess themselves in relation to their understanding of place value, multiplication and division by putting either B (beginning), P (Practicing) or M (mastery) into a box against a particular skill. Self assessments are particularly useful because they provide students with insight into their abilities as well as contributing to confidence building when improvements are noted. Two different pre- and post-tests were administered, one class-based test, and one interview-style test (NSW DET, 2004, pp. 2–3) in which students used concrete objects to demonstrate their grouping strategies. During the interview style test the students were also asked a range of questions to gauge their mental computation abilities and methods. The tests were age appropriate and also consistent with curriculum requirements and *Counting On*. In addition, students maintained a daily journal noting any improvements, comments or misunderstandings.

Action and observations

In Week 3 of the term implementation of the *Counting On* program began. The nine students attended school on a regular basis and enjoyed participating in the *Counting On* activities, often asking if the sessions could run overtime as they were enjoying them so much!

The average score for the pre-test was 6.9 out of 12 correct answers, whereas the average score for the post-test was 10.1 out of 12 correct answers. Figure 2 displays these data in terms of the number of wrong answers recorded before and after the eight week program. Although it is possible that the nine students may have become test-wise, the 8 week period between administrations makes this unlikely.

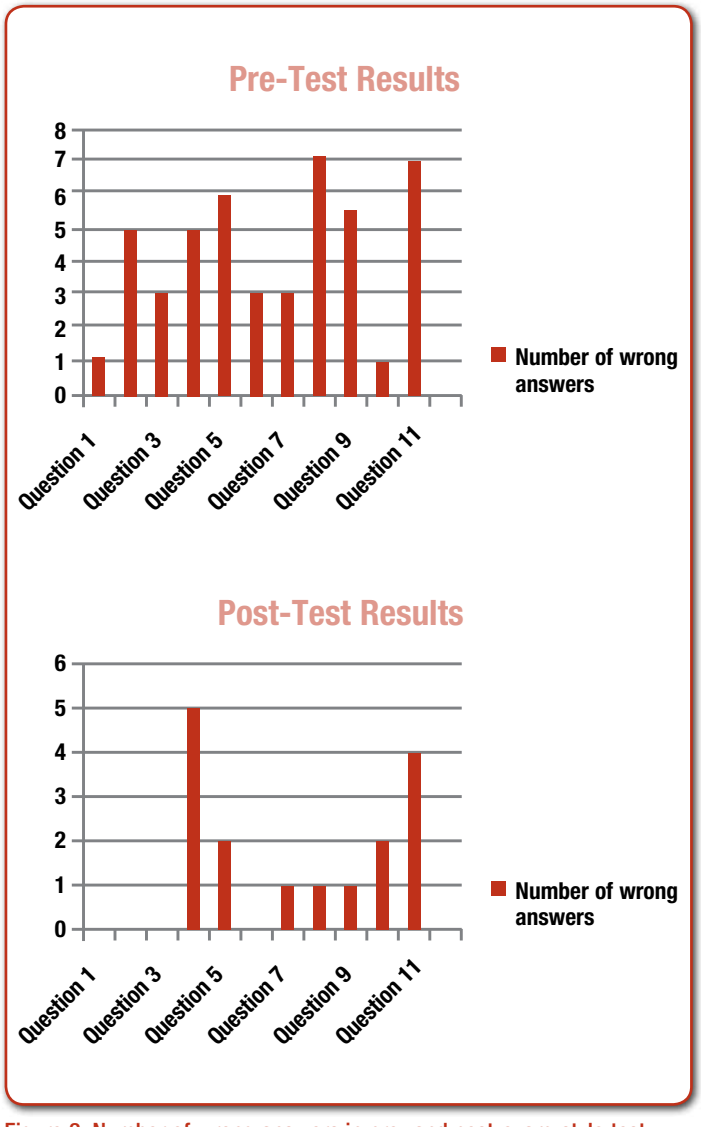

Figure 2. Number of wrong answers in pre- and post-exam-style test results by item for nine students.

There was a decrease in the number of incorrect answers for almost all questions. This was pleasing but closer examination of individual questions yielded further important insights. For example, for Question 4, shown in Figure 2, it was apparent that every student who chose a wrong answer selected the same wrong answer. The students were asked to explain the reasoning behind their responses. Of the five students who answered this question incorrectly, three students admitted that they had not taken enough time to examine the question closely. The other two students seemed to have trouble reading the numbers correctly. Katie then pointed to the correct sequence and explained. Katie believed that these students had not quite grasped the concept of place value and further work in this area would be needed. Question 11, shown in Figure 2, was another question in relation to which little improvement was shown. The question involved a division algorithm. Several students had difficulty with understanding the concept of division, while procedural errors appeared to account for the remaining incorrect answers. Apart from these questions, there was an improvement in every student's scores.

The results from the *Counting On* interview style test (Figure 3) correspond to the five interrelated steps in the *Counting On* framework (Figure 1). The level of each student derives from their method of answering the questions. If the student uses a more sophisticated method to determine their answers, they are ranked higher on the framework. During this test, students are asked, "So how did you come to get that answer then?" and "Did you count on by ones or did you group the numbers?" Following pre-testing in Week 2, the majority of students were at the second or third level of the framework (see Figure 3, light). In Week 10 when they were re-tested, every student had progressed along the scale, and the majority were now on the fourth level (Figure 3, dark).

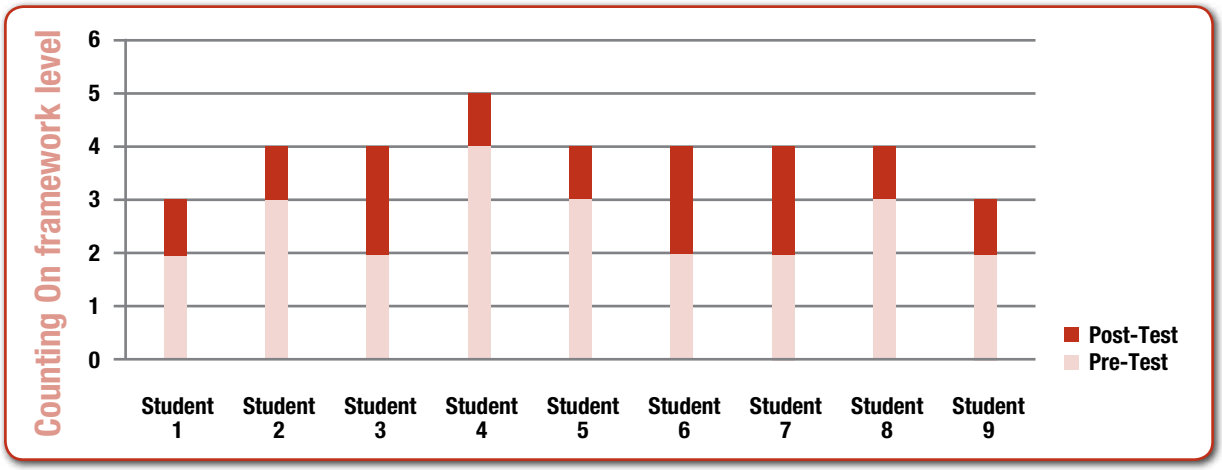

Figure 3. Counting on level reached in pre- and post-interview-style test results (N=9).

The analysis of the students' journals also provided evidence of improvement over time. Katie noted various occasions when students chose to use more effective methods of counting than used previously. For example, on one occasion, she noted that Student 3 was using a very ineffective method to complete a simple multiplication question: "Josh had 20 almonds for recess every day for 2 weeks (14 days). How many almonds did he eat all together?" The student used the strategy of counting by ones—a Level 1 response on the *Counting On* framework. However, in Week 7 when a similar multiplication question was attempted and Katie noted:

> Student 3 ... has moved from concrete materials to mental computation for simple multiplication problems. Today I asked Student 3, "In a hotel there are eight rooms which each accommodate two people. If the hotel has no vacancies, how many people are staying there?" Student 3 was not only able to calculate the answer promptly, she was also able to explain her reasoning for her answer clearly.

Student 3 had, thus, progressed from Level 1 to Level 3 of the *Counting On* framework. Katie monitored each of the nine students in this manner to identify the progress of each over time.

The student self assessment surveys conducted in Weeks 3, 6 and 10 for times tables (Figure 4) indicated that the students believed that they had made improvements in multiplication. There were many fewer Beginner (B) ratings (darkest columns in Figure 4) and increasing numbers of Mastery ratings (lightest columns in Figure 4) by the end of the AR. These data are consistent with results in the other two areas of the self assessment; place value and division. It thus appeared that the targeted students had appeared to have gained confidence in their mathematical abilities in relation to place value, multiplication and division.

Reflection

The implementation of *Counting On* strategies assisted the nine students to progress from relatively inefficient strategies to more sophisticated ones and at the same time to develop their competence. By revisiting the fundamental understandings of place value, multiplication and division, the students developed a sound understanding of these skills.

The students appeared also to benefit from being in an unthreatening environment working with other students at a similar academic level to their own. The students took more risks with their learning than they may have in other contexts and they found the activities enjoyable.

Through implementing this AR project, Katie improved her teaching practice as well as developing her knowledge of the process and benefit of AR. Katie intends to use the processes learned during this AR project throughout her teaching career. Furthermore, she has developed a

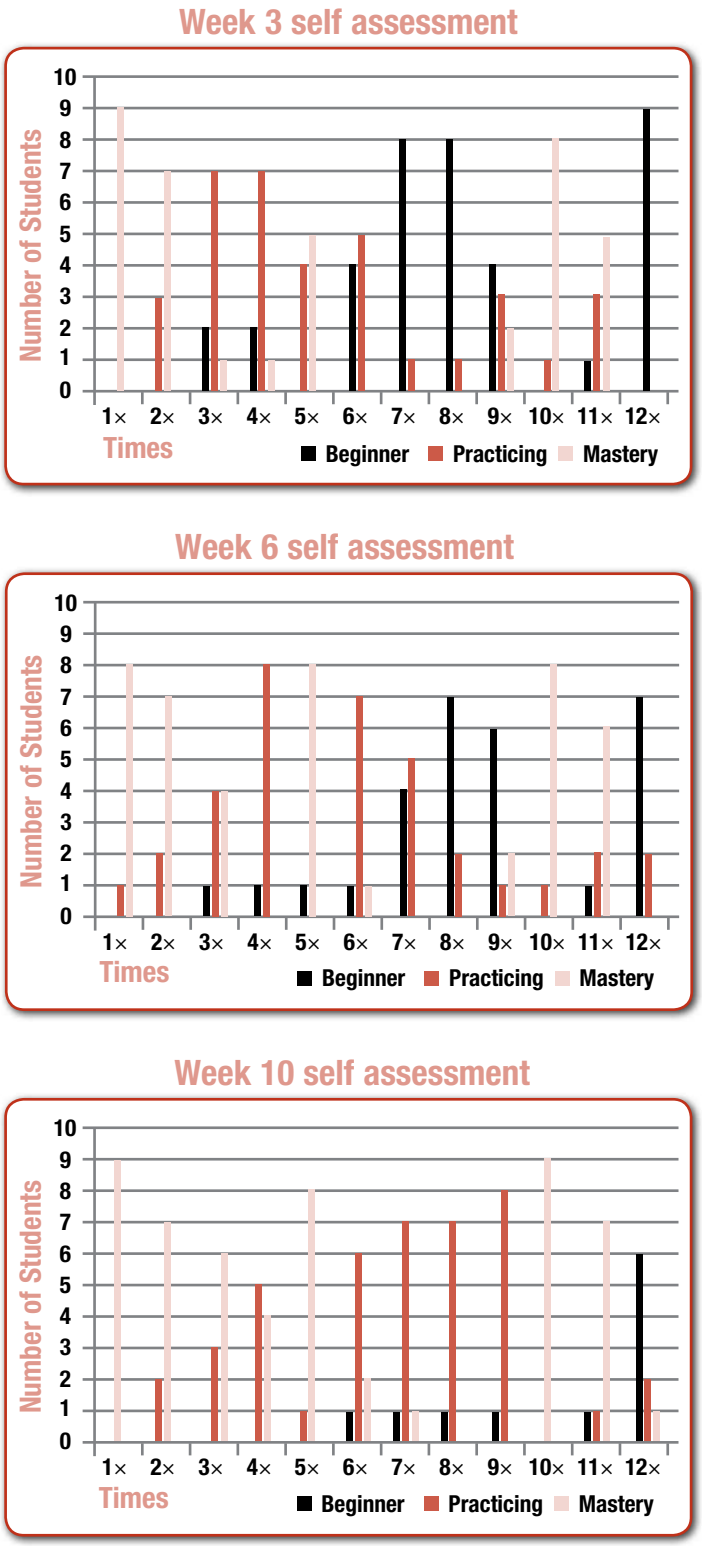

Figure 4. Targeted students' self perception of mastery of times tables at Weeks 3, 6 and 10.

broad understanding of the *Counting On* mathematics program, and the importance of ensuring that students have a firm grasp of the fundamental skills before moving on to more difficult mathematical ideas. Although the AR project has ended, the supervising teacher intends to continue the *Counting On* strategies into his everyday teaching, aiming to bring all of the students up to the highest step in the framework.

Conclusions

For Katie, the AR process was an interesting and rewarding experience. She learned that critical reflection on data gathered over time about teaching and learning can lead to improved teaching practice and student outcomes. Being involved in an in-depth study of student performance gave Katie a sense of accomplishment and satisfaction in knowing that she was able to help the students improve on some vital mathematical skills. She is now equipped with the strategies to assess her practice through action research and will take this experience with her throughout her teaching career.

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